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The Cabinet of the Earth Unlocked.

EDWARD STEANE JACKSON

THE CABINET

OF

THE EARTH UNLOCKED.

BY

EDWARD STEANE JACKSON, M.A., F.G.S.,

SECOND MASTER IN THE TETTENHALL PROPRIETARY SCHOOL.

London:
JACKSON, WALFORD, AND HODDER,
27, PATERNOSTER ROW.

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LONDON: UNWIN BROTHERS, PRINTERS, BUCKLERSBURY, LONDON, E.C.

TO HIS

DEAR LITTLE DAUGHTER,

EMILY CATHERINE,

THESE PAGES

ARE AFFECTIONATELY INSCRIBED

BY HER LOVING FATHER.

Tettenhall Wood,
Sept., 1867.

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Several of the Engravings in this little book are the same as those contained in Messrs. W. and R. CHAMBERS' popular work on Geology, published in their "Educational Course."

PREFACE.

THIS little book has no other pretension than that of affording to the youthful mind amusement, blended with instruction.

Its chief office is descriptive and illustrative, and its chief design to touch the most prominent and salient points of an attractive science.

In looking round the circle of the sciences, it appeared that, above all others, Geology, with its eminently practical tendency, offered most advantages for the author's object, viz., that in some minds the seeds might be sown of desire for the further pursuit of this science in particular, and for the entrance through this as a porch into the magnificent temple of the physical sciences in general.

The author's purpose will be attained, and his work rewarded, if these pages should be the humble means of implanting or fostering the love of the study of nature, and a reverent admiration of the wisdom and goodness of the great Author of nature.

TETTENHALL WOOD,
Sept., 1867.

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CABINET OF THE EARTH UNLOCKED.

CHAPTER I.

CRACKING THE CRUST.

AN old black Chinese cabinet has stood in my hall at Infantia Regis for the last dozen years. Its sweet-scented drawers of cedar and sandal-wood, well stored with curiosities, and crammed with metals and minerals of beautiful colours, and fossils of strange shape, have always had a great attraction for the eyes of my little folk; and when the request has been granted to be shown these enchanted drawers, Papa has been assailed with multitudes of questions, taxing his knowledge, his skill, and every other quality of mind and heart that he happens to possess. Said Papa, therefore, has thought that he could amuse and instruct his half-dozen little wondering auditors by writing for them a simple account of some of the most marvellous things in geology; and he will be very well pleased, if, in putting the results of his labours in this form, he should make other young people take an interest in this pleasing science. One promise I make, by way of preface, that, whereas in geology, as in all sciences, there is a number of hard, long words, taken out of those dreadful Greek and Latin languages, which were evidently only created and preserved for

large tract of land in Jamaica suddenly sank down fifty feet, drowning the inhabitants. About one hundred years ago the volcano of Mexico, called Jorullo, with several others, was suddenly raised up to the height of 1,600 feet on the plain of Malpais. The same sort of hubbub, on a much grander scale, lifted up the Alps and Andes, and sunk the Pacific and Atlantic Oceans.

Now this granite, which I have told you lines the crust of the earth, and sometimes comes up above the ground and sometimes is hidden far below it, has various colours—blue, green, red, and often almost white—and is composed of three different materials, one of which is a clay,* and two other minerals,† which can easily be distinguished without the help of a glass. The clay being softer than the other two is sooner acted upon by the air and weather, and thus granite rocks often assume grotesque forms, as the Cheese-wring in Cornwall. Sometimes the clayey part is

reduced to a fine white powder, which, after being well washed, is sent to the potteries, where it is manufactured into porcelain and china.

Granite, and some other rocks very much like it, have all the appearance of having once been in a melted state, and of having then gradually cooled down; but the other rocks, such as lime-

* Felspar.

† Quartz and mica, often, but improperly, called talc.

stone, sandstone, or chalk, were deposited from water in a manner which may be illustrated thus:—If you throw two or three handfuls of fine sand or powdered chalk into a hand-basin of water, so long as the water is agitated the particles of sand and chalk will float about in it, but when it subsides they will sink by their weight to the bottom and form a bed, or layer, or *stratum*. So these rocks were formed at the bottom of the sea, and the remains of any animals that lived in the sea were imbedded in them and became FOSSILS; and if this bed was afterwards heaved up so as to become dry land, these fossils would be found on the tops of mountains, or at some considerable elevation above the level of the present sea. When we know this fact we can understand what Tennyson says in his beautiful stanza:—

> "There rolls the deep where grew the tree.
> O earth, what changes hast thou seen!
> There where the long street roars, hath been
> The stillness of the central sea."

Now these beds, though when first laid down they must have been pretty level, have by no means continued so, but have been bent up, broken asunder, set up sometimes quite on end, or turned completely over.

Many of these rocks are entirely composed of very small shells, which can be seen distinctly through the microscope, and you will be able, without this help, to see them in a piece of the white Bath stone which is used so much in building; and a rock of this sort ground small and made into a paste with water was used as food by a half-savage tribe, who thus got the reputation of being "DIRT-EATERS."

Thus we see that fire and water have had most to do in preparing the earth to be the abode of man. How long a time it required for all the water-rocks to be laid down upon the fire-rocks we cannot tell, as they are of various thickness, and would be laid down slowly or quickly according as the sea was boisterous or quiet. It is probable that the process was going on many thousand years before Adam was created. The

chief water-rocks, in the order in which they were formed, are:—slate, Welsh limestone,* old red sandstone, coal, new red sandstone, another limestone,† to which the Portland and Bath building-stone belong, chalk, and the later rocks; ‡ and it is very useful for miners and engineers to know that these rocks always occur in the same order, so that it is useless to dig for coal in a part of the country where old red sandstone is found; and if this had been known, many thousands of pounds would have been spared, for people have sometimes spent much time and money in digging for coal where it is impossible for coal to be found.

Geology is a very young science—scarcely yet a hundred years old; but in this hundred years much has been done and a great many discoveries have been made, but there is no doubt a great deal more to be done yet. On the other hand, astronomy is one of the oldest sciences, and began to be studied in quite early times, and there are many reasons why this was so. Men found the stars very useful to guide their ships by, before the mariners' compass was invented, and from their rising and setting to determine seasons of the year. There was also such beauty and mystery about those bright distant bodies that mankind fell to worship them as gods which had an influence over their lives, and fetched down teachings from the stars before they found

"Tongues in trees, books in the running brooks,
Sermons in stones, and good in everything."

* Silurian system. † Oolite. ‡ Tertiary system.

CHAPTER II.

EMPRESSES, DUCHESSES, AND OLD HUNDRED-EYES.

ITTLE FOLKS! My very good friends! I dare say you have sometimes seen a slice cut out of a plum-cake, or of a plum-pudding; and you know that the plums and currants are enclosed and imbedded in the dough of which the cake or pudding is made. Now these plums and currants are something like the *fossils*, as they are called, which are found imbedded in the rocks which compose the earth's crust. That is, they are the remains of animals—fish, flesh, and fowl—shell-fish, insects, flies, with their soft parts decayed, but their bones and forms preserved, that have lived and died on the earth, and have become as hard as stone. There are fossil elephants, sharks, dragons, flying lizards, butterflies, and birds; but scarcely any animals like the creatures that are *now* alive upon the earth; and no fossil men and women. Therefore, it is said, all these creatures lived *before* (and most of them ages before) Adam and Eve were created.

We are familiar enough with the sight of a dead animal—as a horse, dog, or fly—but it is not so easy to find instances of a whole species or class of animals dying out. There are two cases, however, recorded by history, of this law, which we shall be interested in dwelling a little upon. The first of these is that of the bird called the *Dodo*. There is no such creature as the Dodo now to be seen, but there is a full-length portrait of him in the British Museum; and the early navigators, who visited the Mauritius between 1606 and 1679, describe to us a bird which they found there like a large goose, but very tough to eat, with silly little wings and a silly little tail, and very, very stupid. This bird they called *Dodo;* but since the last date no voyagers

it is not found on that island now, or anywhere

the Dodo's portrait in the British Museum.

Bison, called by Cæsar,

meaning *ox*, which

Forest in Germany, and

less than an elephant in size,

It has great

which it has

strength, and swiftness in carefully

men among them

these beasts in

The young men among them

practise their skill in hunting

largest number of them, publicly

their prowess, gain great

and domesticate the *Urus*, even

The large size and shape of the

those of our oxen. They are

with a silver rim, are used as

table banquets."

this particular species of bison no

has happened to the *Urus* and

Dodo in the times of man, so it happened to innumerable species of animals which existed before the times of man, and have left their bones, shells, and footprints in the rocks of the earth.

The two rocks that have been formed after and upon granite are very much like granite in appearance, and are indeed made of the same minerals, though in much smaller pieces,* and they were, no doubt, composed of little particles washed by the water off the granite, and then laid down in a separate bed upon it. These two rocks, together with their parent granite, are distinguished as having no fossils, or remains of plants and animals. Probably the intense heat of the earth at that time forbade the existence of either animal or vegetable life. They afford, however, *garnets*, and other precious stones; *potstone*, which is made into very pretty jars; and the well-known mineral, *asbestos*, which, in moderate bulk, will bear any amount of heat without being consumed or melted.

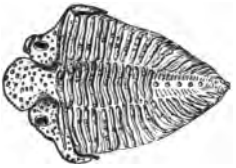
The next important rock above these is *slate*, which is found in Cumberland, Wales, and Cornwall. *Slate* is clay baked very hard, green and purple in colour; some is fine and some coarse. A slate quarry is a very interesting object to visit; and the Penrhyn quarry, near Bangor, is very famous. It "is worked in twelve galleries of horse-shoe form, one above another. Each gallery is forty feet high, the highest being five hundred feet above the lowest. Upwards of three thousand men are employed here, and the daily make exceeds five hundred tons."† The slates, when cut, receive, according to their sizes, the fantastical names of Empresses, Duchesses, Countesses, &c.

Next above these clayey rocks occurs a limestone which is found in England, chiefly in South Wales, and hence called the *Silurian* system, because the Romans gave the name of *Silures* to the inhabitants of South Wales, and this is the first that yields fossils in any abundance. The most interesting of these is the *trilobite*, so called from the three lobes of its body, of which great

* They are called *gneiss* (pronounced *gnice*), and mica *schist* (*shist*).

† Ansted's Geology, in "Orr's Circle of the Sciences," p. 211.

numbers of various kinds are found. It does not now exist. Its body was covered with scales, and its tail flexible, to use as a



(Fig. a.)

rudder. Some think it had little fins, or paddles, to scull itself along. But it is certain it had a most wonderful pair of eyes. Each eye was provided with four hundred lenses, fixed round a cone, so that the animal, as it lay at the bottom of the waters, could see everything going on round it; the inner portion of each cone is, however, not supplied with lenses, as they could only look across to the opposite cone, which would have cut off the view. The creature had the power of rolling itself up into a ball (as in fig. b) something like the common wood-louse. The

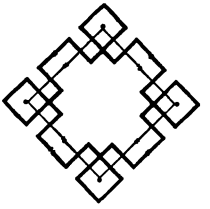
(Fig. b.

existence of this beautiful eye shows us that at that early time the same light and air surrounded the earth as now, and that the waters of the sea were clear. It would argue a great want of wisdom and of kindness in a Creator to provide His creatures with powers which they were prevented from using; and the more we study nature the more beautifully we shall find the conditions of its life adapted to the powers and gifts of the creature. Has it teeth to chew, and a stomach to digest? Then food springs up out of the earth. Has it wings to fly? Then the

elastic air buoys it up. Fins and a rudder-tail? The water sustains it, speeding it on its way.

Geology has always been a favourite study of our countrymen; and some of the most distinguished geologists have been, and are, Englishmen. Perhaps the chief cause of this tendency may be found in the fact, that in our little island, so small compared with other countries, are contained all the principal layers of rocks, or strata, most of which are abundantly furnished with their proper minerals and fossils. Another curious circumstance, as you will see by looking at a Geological Map of England,* is that the oldest rocks are all found on the west of the island, as in Cumberland, Wales, Devonshire, and Cornwall; while the middle-aged and newest occupy the centre and eastern side. In this way Englishmen are able to study geology practically without leaving their own shores. Moreover, the pursuit of this science is absolutely necessary to work with the least expense and greatest profit the minerals in which England is so wealthy; and a good miner or engineer is obliged to know much of the nature and position of rocks.

* Such a one may be obtained for a trifle of J. Reynolds, 174, Strand.



CHAPTER III.

HUGH MILLER: HIS QUEER FISHES—WING-FISH, BERRY-BONE, AND BUCKLER-HEAD.

Y good little friends! I am going now to introduce you to the strangest fishes I suppose you ever saw. They come out of the Old Red Sandstone, which lies next above the Silurian rocks, and is found chiefly, and to a large extent, in Scotland. This system is very interesting in itself, and is more interesting still from its connection with the name of a very eminent man—HUGH MILLER. I think it will please you to hear something of the life of this great man, before I tell you about these funny fishes.

Hugh Miller, then, was a Scotchman, born at Cromarty in 1802. His father followed the family calling of a sailor; and Hugh was still a child when his father was lost in a ship, of which he had risen to be owner. At the Cromarty parish school, to which he was sent, little Hugh distinguished himself by his love of reading, and his fondness for poetry; but he received his first taste for science from the instruction which an uncle gave him in natural history. Notwithstanding his literary and scientific aspirations, however, his circumstances obliged him to enter upon the humble occupation of a working mason; but it was in this employment that, while working blocks of stone in the quarry, he was also working out his future fame; and in these blocks he was unconsciously laying the foundation of his celebrity;—

> "His to-days and yesterdays
> Were the blocks with which he built."

Among blocks, however, he could not resolve to pass all his life, and when an opportunity offered, he gave up his mason's trade, and became a clerk in a Cromarty bank. Here he found more leisure for the pursuit of literature; and, at length, having

done the "Free Church" good service by one of his publications, he was appointed editor of the *Witness* newspaper, which advocated the views of that party. A series of papers which he wrote for this journal entitled him to take rank as one of the foremost geological discoverers; and high praise was bestowed upon him at the first meeting of the British Association, in 1840, by leading scientific men. Sir Roderick Murchison "spoke in the highest terms of Mr. Miller's perseverance and ingenuity as a geologist. With no other advantage than a common education, by a careful use of his means, he had been able to give himself an excellent education, and to elevate himself to a position which any man, in any sphere of life, might well envy." Dr. Buckland said, "he had never been so much astonished in his life by the powers of any man as he had been by the geological descriptions of Mr. Miller. That wonderful man described these objects with a felicity which made him ashamed of the comparative meagreness and poverty of his own description in the *Bridgewater Treatise*, which had cost him hours and days of labour. He would give his left hand to possess such powers of description as this man."*

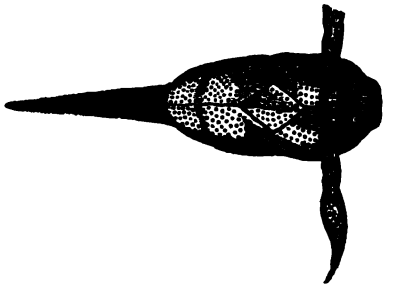
This useful and meritorious life had a sudden and melancholy close. On the day before Christmas-day, 1856, he was found dead in his own museum. His brain had been wearied by much study; and it is supposed that in this excited state, having apprehensions of robbers, he shot himself while walking in his sleep.

But it is time that we should turn from the man to the wonderful creatures which have given him fame. I have selected three of the strangest. The first, which is here figured, is called WING-FISH,† looking like "a fish in the act of wishing itself into a bird." There are wings which want only feathers, a body

* The papers contributed to the *Witness* have been collected into a volume, under the title of "The Old Red Sandstone; or, New Walks in an Old Field." In another work, entitled "My Schools and Schoolmasters," Miller has given a deeply interesting account of his own life.

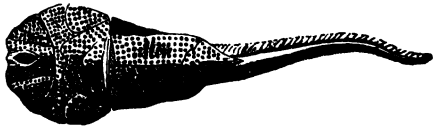
† Its scientific name is *Pterichthys*, from two Greek words, *pteron*, a wing, and *ichthys*, a fish.

which seems to have been as well adapted for passing through the air as the water, and a tail by which to steer. "Imagine,"



says Hugh Miller, in his humorous description, "the figure of a man rudely drawn in black on a grey ground, the head cut off by the shoulders, the arms spread at full, as in the attitude of swimming, the body rather long than otherwise, and narrowing from the chest downwards, one of the legs cut away at the hip-joint, and the other, as if to preserve the balance, placed directly under the centre of the figure, which it seems to support."* The arms were weapons of defence, which the creature, like the bull-head of our rivers, erected in times of alarm; and it is a strange fact that very nearly all the specimens of this fish bear this attitude.†

The second fish, of which here you have the portrait, you may call Berry-Bone,‡ from the tubercles or pimples with which its



bony plates are covered. The figure of this creature Hugh Miller compares to "a boy's kite. There is a rounded head, a

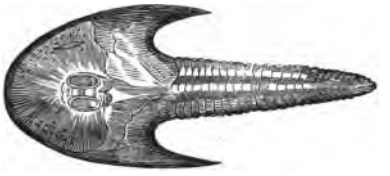
* "Old Red Sandstone," chap. 3.

† The arms or wings in the *figure* should have been made uniform.

‡ *Coccosteus*, from *coccus*, a seed or berry, and *osteon*, a bone: Greek words.

triangular body, a long tail attached to the apex of the triangle. The manner in which the plates are arranged on the head is peculiarly beautiful."* In the stomach of one of these fossils are discovered by the microscope minute scales in large numbers, the remains of fish which the animal had eaten; and in another are found small pebbles, which had been swallowed together with the food.

The third fish is the BUCKLER-HEAD.† "Has the reader"—I



am borrowing again from Hugh Miller—"ever seen a saddler's cutting-knife? a tool with a crescent-shaped blade, and the handle fixed transversely in the centre of its concave side. We have but to give the handle an angular instead of a rounded shape, and to press together the pointed horns of the crescent, till they incline toward each other, to produce the complete form of the *Cephalaspis*. In the centre, and placed closely together, as in many of the flat fish, were the eyes. The creature's head was cased in strong plates of bone, the whole upper side lying under one huge buckler—and hence the name *Buckler-head*."‡ This plated head surrounded by a sharp edge was a weapon of defence; and is compared by Miller to the *Boomerang*, "which is capable of being cast with such force, that it has been known to sever a horse's leg through the bone. Its impetus, however, must have been comparatively small, for its organs of motion were so: it was a bolt carefully fashioned, but a bolt cast from a feeble bow. But if weak in the assault, it must have been formidable when assailed."

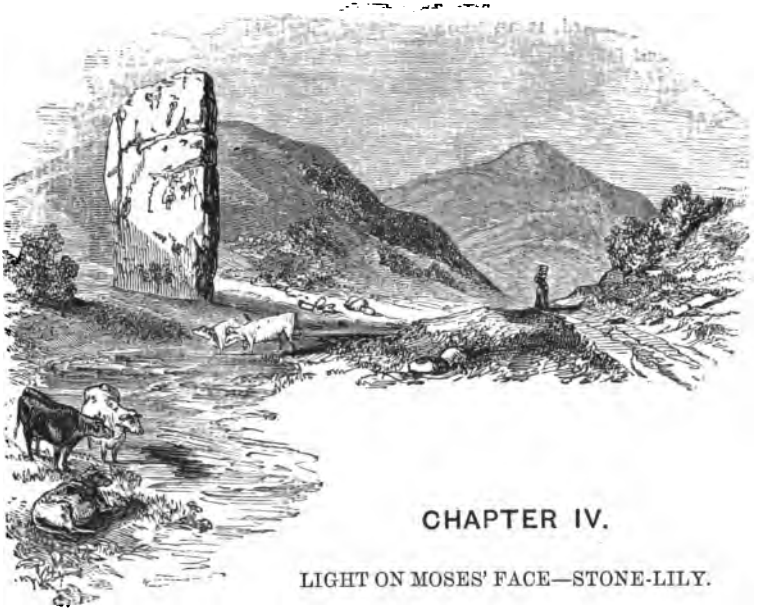
* "Old Red Sandstone," chap. 3.

† *Cephalaspis*, from *cephalé*, head, and *aspis*, buckler: Greek words.

‡ Abridged from "Old Red Sandstone," chap. 8.

In Scotland, as I have told you, the Old Red Sandstone is very fully developed, and these rocks form a thick and deep frame round that country, just as a frame surrounds a picture. In England the formation is found in Devonshire, but the fossils there are of a quite different character—none of the outlandish Scotch fishes—none of Hugh Miller's heavy armed, thick-plated cavalry; but shells small and delicate, and inoffensive creatures like the *trilobite*. The difference is probably owing to the character of the seas in the two parts, that in Scotland having been deep, liable to storms and tempests, affording a habitat only to strong, sizeable creatures, able-bodied and well-cased; that in Devonshire having been of smaller compass, calm and unruffled, giving harbourage to smaller and more delicate denizens. And now let me tell you that, with even the little knowledge of geology you now possess, you will be able to go through the rooms of a museum with, not only wonder, but with a great deal of interest and intelligence; and you will feel as if you had a new sense, when, with hammer in hand, you sally forth intent to find fossils for yourselves, and wind

> "About the cliffs, the copses, out and in,
> Hammering and clinking, chattering stony names
> Of shale and horn-blende, rag and trap and tuff,
> Amygdaloid and trachyte."
>
> *Tennyson's "Princess,"* p. 72.



CHAPTER IV.

LIGHT ON MOSES' FACE—STONE-LILY.

DEAR Hearers! Though it is not my wish in these papers to do more than touch a few of the most interesting and wonderful points of geology, and the connection of its teachings with the opening chapters of the Bible do not come within my purpose, yet I cannot refrain altogether from saying something about the subject, especially as I have seen that some things I have said have excited some surprise in you. You have, for instance, wondered to hear me say that it must have taken many thousand years to lay down all the different beds which compose theearth's crust, while you know that Moses says it was all done in six

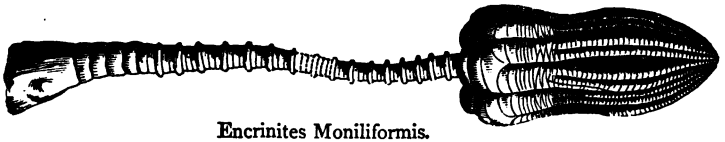
days. Now the "Old Red Sandstone" alone, about which you have last heard, is in some parts of England no less than *ten thousand* feet thick; and we must either suppose—what seems indeed utterly impossible—that this immense thickness of sand was all deposited, and that the swarms of creatures whose remains it covers and imbeds, were all born and finished their lives in the course of twenty-four natural hours, or we must seek some other explanation. The above supposition would require a very unnecessary and extravagant miracle, which would contradict all that we learn from nature of God's usual method of working; but all this difficulty may be easily obviated by a simple explanation. And it is this: That the six days of Moses are not to be strictly understood to denote natural periods of twenty-four hours' length; but, according to a familiar usage of language, times of indefinite duration; and so the seventh day, in which God rested from His works, maintaining and supporting what He had made, but creating nothing new, will have lasted up to this time, and not yet have ended. Some have thought that the six great acts of creation were presented to Moses in six distinct visions, on six consecutive days, and that what he records as the work of each day is what he saw pass before him each day in a magnificent scene. A second difficulty you may have felt in finding that death reigned amongst these creatures before Adam and the Fall; but on a little reflection you will see that the Bible gives no countenance to the notion that the inferior animal creation became subject to death in consequence of Adam's fall, but only that it entailed this penalty upon man and *his* race. We need not indeed suppose that even within the charmed limits of Paradise itself, any creatures but man were exempt from this natural end of life, but rather infer from the very sentence, "Thou shalt surely die," that Adam must have understood its meaning from his having witnessed the lifeless bodies of some of his subjects. A third difficulty—and the last I shall touch—concerns the existence of the sun and his light. The perfect eyes of the Trilobite and of the Bucklerhead prove the presence of light in their day.

Legs are given to walk with, noses to breathe with, teeth to chew with; and creatures that have legs, noses, and teeth, are intended by their Maker to walk, breathe, and chew; and have provided for them something to walk upon, something to breathe, and something to chew. In the same way we conclude that creatures furnished with eyes were also provided with light. Now Moses* says, "God made two great lights;" that is, the sun and the moon, on and not till the fourth day, long after Trilobites and Bucklerheads had ceased to exist. But there is really no difficulty here, when you know that the word "made" does not mean "created," but only "appointed." The great sun, the centre of our system, which keeps our earth and the other planets in their orbits by his attraction, must at least be as old as any of them, and the work of the fourth day was the clearing away of dense vapours surrounding our globe, through which had penetrated a partial and imperfect light, and the admission to it of the full glare and heat of the sun's rays.

To proceed now with our main subject—the beds which lie next above the old red are those called mountain limestone. In England these rocks are found in Derbyshire, and in some of the counties to the north of it; and they impart to the scenery a very bold and picturesque appearance, diversified by the mountain ash and wild flowers peculiar to this soil. At the beginning of this paper is a picture of the beautiful valley in Derbyshire, called Dove Dale, which will give you a notion of the beauty of this scenery.

Amongst the fossils of this formation are found many beautiful corals, shell-fish, single and double-valved shells. This one, which I wish you particularly to notice, is commonly called the "Stone Lily," from its similarity to that flower. It is not, however, a plant, but the skeleton of an animal. It consisted of an immense number of little bits, beautifully and neatly fitted to one another. No less than twenty-six thousand have been

* Genesis i. 16.



Encrinites Moniliformis.

counted in some specimens. These bits were attached together by cartilage, and the whole animal was probably covered with a jelly-like substance. Though no plant, it as it were grew upon the rocks to which it was fixed, but was so flexible that it could sweep the waters on all sides within its tether. The first of its names expresses its likeness to a lily, and the second its resemblance to a necklace; for down the middle of what we may call the stalk ran a cord like the pith of a tree, stringing the rings together as the beads on a necklace. The base of the cup at the top of the stalk contained the mouth and stomach, and the small arms issuing from the base were feelers which moved about freely, catching the prey and conveying it to the stomach. Entire specimens of this fossil are seldom or never found, as the jelly-like flesh and the soft cartilage which joined its parts soon decayed, and the pieces were drifted about by the waters in which it had lived. Limestone beds of more than one hundred feet thick are entirely composed of these remains, and blocks and slabs quarried from these rocks, and polished, are used for chimney-pieces, and other ornamental purposes.

"They say," sings Tennyson*—

> The solid earth whereon we tread,
> In tracts of fluent heat began;
> And grew to seeming random forms,
> The seeming prey of cyclic storms,
> Till at the last arose the man."

Some of these seeming random forms we have already seen; more are still to come before the "solid earth" will be sufficiently prepared for "the man." Meantime, we may well pause in

* In Memoriam, cxvii. p. 183.

wonder and thankfulness for the elaborate care and wisdom displayed by Him whose "delights are with the sons of men," in furnishing our home for us with things beautiful and useful; and when the microscope shows us in our crushed rocks that every footstep treads upon the ruins of worlds, and we feel tempted to magnify the importance of man in the schemes and designs of the Creator, we may turn to the telescope, revealing myriads of worlds around us, and exclaim, with David's humility, "What is man, that thou art mindful of *him?*"

CHAPTER V.

DIAMONDS, BLACK AND WHITE.—SQUELCHED BEETLES.

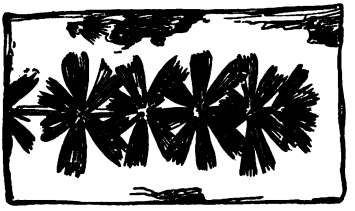
THE beds and deposits to which we now descend—called the COAL MEASURES—show, more than any others, the gracious provision made by the Creator, as He built the earth, for the necessities and comfort of man; how in the remote ages He was already "rejoicing in the habitable part of His earth," and the "delights" of Eternal Wisdom were thus soon "with the sons of men."* Up to this point you have seen *wonders*—instances of the power, skill, and varieties of design of the Great Architect; now you will see *signs*—proofs of His goodness and foresight to supply the wants of the highest of His terrestrial creatures. You have seen things "rare;" now, like a second interpreter, I will show you things "profitable;" and having led you, swiftly indeed, through some of the chambers of the earth, hung with strange pictures and imagery, come with me now into her cellars, as it were, in which is stored up fuel to light our fires yet for centuries.

You must first of all clearly understand that what we now call

* Proverbs viii. 31.

coal (for in the Bible and in ancient writings generally *coal* means *charcoal* or burning *wood*), and which is a *mineral*, has been altogether formed of vegetables and trees, and that during the period at which we have arrived the land was thickly covered over with an immense growth of ferns, peat, horse-tails, tree-ferns, pines, cactuses, and many other trees and plants, now extinct, of the juicy sort, such as grow in tropical climates. These forests and jungles flourished for their day, fell down and decayed, sank below the level of the sea, were covered over with sand and silt, pressed close by rocks formed subsequently upon them, and by degrees *carbonized* or turned into coal. Beds were sometimes raised again several times, and fresh seams of coal formed, and it required a large quantity of vegetable matter to form even a thin seam. The thickest coal-bed known in England is thirty feet,* while some are mere black strips.

The vegetable origin of coal is clearly seen by looking at a thin slice through the microscope which shows the woody fibre; and coal also very often retains the shape of the plants which formed it. Thus we find impressions of ferns; as this:—



It is called *Toothed Wedge-leaf*.†

But more curious still are the accounts of whole trees and even forests being found in an upright position just as they grew, as for instance, the following in a colliery near Wolverhampton:—"This presents the appearance of a moor on which a full-grown

* In the Dudley basin, Staffordshire.

† *Sphenophyllum Dentatum*, from *sphen*, a wedge, *phyllon*, leaf, *Greek words*, and *dentatus*, toothed, *Latin*.

fir wood had been cut down a few months before, and only the stumps left behind. Stump rises beside stump to the number of seventy-three in all: the roots strike out on every side into what had been once vegetable mould, but which is now a hardened brownish shale. Many trunks, sorely flattened, lie recumbent on the coal, some of them full thirty feet in length, while some of the larger stumps measure rather more than two feet in diameter. There lie thick around several kinds of coal-trees; and yet the seam of coal formed by this ancient forest does not exceed five inches in thickness. The prostrate forest had been submerged, and fishes swam over it. This upper forest is underlaid by a second, and even a third; we find three full-grown forests closely packed up in a depth of not more than twelve feet."* Petrified forests have been discovered in other parts of England, as well as in other countries.

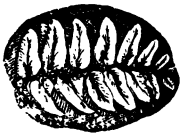
There are different kinds of coal; as *Brown coal*,† which is imperfectly formed, and shows its woody character very distinctly; this is not good fuel: *Caking coal*, our common burning coal, the most useful: *Cannel coal*, which is shiny and does not soil the fingers, and is often worked into vases and other ornaments. It also yields a large quantity of very pure gas, and is used to a great extent in gas works: and lastly, *Jet*, which is true coal; the finer sorts are used for ornaments, and the coarser sorts for fuel.

The coal-beds are not only valuable in themselves, but also as lying in association with one of the commonest and most useful of the metals, viz., *Iron*, and for this reason we obtain iron goods so cheaply. The metal is found in great abundance, but not in a pure state, and it needs the coal to melt it, or *smelt* it, and separate it from the dross: and so, if the coal were found in the north and the iron in the south, or *vice versâ*, and one had to be carried to the other before the iron could be worked, the value of iron goods would be greatly increased, and our national prosperity

* This description (slightly altered) is taken from Dr. Mantell's *Wonders of Geology*, ii. 688.

† *Lignite*, from *lignum*, Latin, *wood*.

greatly diminished. Here then we have an additional reason for naming this formation the most useful of all, and an additional call to admire with gratitude the Creator's provision for man's advantage. The *Clay Ironstone*—as the ore is called from which the metal is extracted—is generally found in regular lines of nodules, or nuts, each containing a sort of kernel, as a leaf, a fish's tooth, or a fish's scale. These two specimens are—1. Part of a fern leaf; and 2. A piece of lime, giving the appearance of a



squelched beetle. The process of separating the iron from the ore can be seen better than described; and he who has travelled through the Black Country, as the midland iron district is called, especially at night, with innumerable furnaces blazing around him, and the dark forms showing like very demons stirring up their fires with pitchforks, may perhaps think Milton's famous lines no poor description of the scene, as

> "He views
> The dismal situation waste and wild;
> A dungeon horrible on all sides round
> As one great furnace flamed; yet from those flames
> No light; but rather darkness visible
> Served only to discover sights of woe,
> Regions of sorrow, doleful shades, where peace
> And rest can never dwell."
>
> MILTON, *Paradise Lost*, Book I.

But here in this country, so ugly by day and hideous by night, lies one of the greatest sources of England's wealth. But according to the common saying, "Extremes meet," and a slight change may turn black into white, I will close with a curious illustration of this fact. The white diamond (for diamonds often

have colour, as yellow, orange, pink, brown, and black), the most precious of precious stones, is entirely composed of the principal ingredient of black coal—is in fact another form of charcoal, and formed from vegetable matter. It is formed out of decay and corruption, and can be burnt up with a less heat than would melt silver, while by the addition of a few more elements coal is produced. So the clear white diamond of truth may be turned into the black coal of falsehood; and those are the most mischievous lies which contain a portion of truth, and are "founded on fact."

CHAPTER VI.

"Watch
The sandy foot-prints harden into stone."
Tennyson.

EAR Young Folks! The next rocks to which we come, after leaving the coal-beds, do not contain such an abundance of fossils as some of the lower layers, but are still very interesting. They form the "New Red Sandstone," which is found largely in the central parts of England. Though these Sandstones are called *Red*, all the beds belonging to the series are not red, but sometimes yellow, blue, and mottled. It will help you in remembering the order of the rocks, to notice that the coal-beds lie between the *Old* Red Sandstone, which is below them, and the *New* Red Sandstone, which is above them.

A curious feature of this formation are the impressions which were made upon the sand when soft, and which have since "hardened into stone." Slabs have been found with furrows and ridges made by the ripple of the wave, just as you may see now on a sandy shore, as that of Hastings, when the tide is out. Others are found pitted with little holes, which must have been made by rain-drops, and which show by their shapes that

the rain fell upon some perpendicularly, and upon others with a slanting shower. Besides these we find in a literal sense,—

"Footprints on the sands of time."

Not, however, human, but those of birds and beasts. In America many impressions of birds' feet have been discovered, varying from half an inch to twenty inches in length. "There were giants in those days," as the following description will fully testify: "I have," says Dr. Deane, "in my possession consecutive impressions of a three-toed foot which measures eighteen inches in length, by fourteen in breadth between the extremities of the lateral toes. Each step will hold half a gallon of water, and the stride is four feet. The bird must have been four or five times larger than the African Ostrich, and could not have weighed less than 600 pounds. Every step the creature took sank deep into the stratum, and the sub-strata bent beneath the enormous load. If an ox walk over stiffened clay he would not sink so deeply as did this mighty bird."

In Dumfriesshire, and afterwards in Cheshire and in Saxony, were discovered strange footprints of some unknown four-footed animal, as in the cut—

The impressions, you observe, are of five toes, one of them very like a thumb; and because of their resemblance to the human hand, the beast that made them was called *Hand-beast.** Moreover, the large prints are those of hind-feet, and the small

* *Cheirotherium*, from Greek *Cheir*, hand, and *therion*, beast.

ones of fore-feet, like the marks a toad would make. Some time afterwards some bones were found of a huge frog. It was concluded that this reptile belonged to the footprints ; and in the preceding cut you see the creature making them. The outlines on the animal's body show the bones first found. From a wonderful structure of the tooth the name has been changed to Labyrinth-tooth. *

This next fossil is that of the shell fish called *Ammonite.*

Different kinds of this creature were very abundant in many formations. It does not exist now, but it was very much like the modern Nautilus. The name is taken from the ram's horn represented on the head of Jupiter *Ammon*. They are found of all sizes, some quite minute, and some will measure 14 feet round.

"Huge Ammonites and the first bones of time." †

They belong to the class of shells called chambered; the animal living only in the outer chamber, partitioning off, as it grows, its spare rooms with the lime which it gets from the sea water. These empty spaces it needs to enable it to rise to the top of the water, and by this exquisite architecture, as it increases in weight by growth, it still maintains its balance. But as it does not always want to be floating about on the top of the water, it has an admirable contrivance by which it can sink at pleasure. This is a sort of tube (the siphuncle) which, proceeding from the heart, runs through all the empty chambers to the end of the shell, and

* *Labyrinthodon.* † Tennyson, *Princess*, p. 2.

when the animal withdraws entirely into the outer chamber, the pressure upon the heart forces its fluid into the tube, and the shell becomes so much heavier that it sinks. But we have not yet done with the skill of this architect. Observe the markings on the shell; they are the tracings of the lines where the walls of the chambers touch the shell, and the object of them is, by a device well known to builders, to give strength and support to the shell, which else would have been too weak to resist the pressure of the water, and would have been liable to be crushed in by it. In the Ammonite, these lines are sometimes exceedingly varied and beautiful, and may be imitated in patterns of ornamental needle-work; in another species they are zig-zag; and in the Nautilus, the shell of which is much stronger, they are simple curves. The above description in general will apply to the Nautilus as well as to the Ammonite; but besides the distinction already noticed, the Nautilus differs in having a wider mouth, and its tube pierces the centre of the walls, while that of the Ammonite runs along the outer shell.

It is in the New Red Sandstone beds in England that enormous masses of salt are found, though the mineral is not confined to this formation in other countries. This important and abundant substance, so essential to life, is compounded of two things, either of which, if taken separately, would destroy life. In Cheshire there are beds of salt 120 feet thick; but Droitwich, in the middle of Worcestershire, yields the strongest and purest. In the time of the occupation of Britain by the Romans salt mines were worked at Droitwich, and they still yield an inexhaustible supply, many thousand tons being annually obtained from them. A fountain of salt water continually wells up; and from one spring alone a weekly produce of one thousand tons has been obtained. "At a distance of from thirty to forty feet below the surface there is a bed of hard gypsum, about 150 feet thick; through this a small hole is bored to the river of brine, which is in depth about twenty-two inches, and beneath which is rock salt. The brine rises rapidly through the aperture, and is

pumped into a capacious reservoir, whence it is conveyed into iron boilers for evaporation; it is supposed to be stronger than any other in the kingdom, and contains above one-fourth part its weight of salt. One of the shafts is sunk to a depth of nearly 500 feet, and passes through four layers of salt, 85 feet in aggregate thickness." *

CHAPTER VII.

"Gorgons, and Hydras, and Chimeras dire."

EAR Little Friends! The beds which lie next in order above the New Red Sandstone are arranged in three divisions, the lowest of which is called *Lias*, which is said to be a corruption of the word *Layers*. The prevailing colour of these is blue. The middle division is called Roestone,† from its resemblance to the hard roe of a fish. The resemblance may be seen very plainly in the stone of Bath, which is used so much in building; but in some sorts the particles cannot be distinguished without the help of a glass. The eggs or grains are formed of lime collected round some minute kernel, as a shell or bit of coral, but sometimes are found to be hollow. The third and topmost division is styled *Wealden*, from its forming the *Wealds* or *Wolds* of Kent and Sussex. A principal feature of this period was the existence of lizards of an enormous size, and it has been therefore called the Age of Reptiles, or of Sea Dragons. They are Tennyson's

"Dragons of the prime,
That tare each other in their slime."

About forty species of these creatures have been made out.

* Mantell, *Wonders of Geology*, vol. ii., p. 541.

† Or *Oolite*, from *oon*, egg, and *lithos*, stone, Greek words.

One, called *Iguana-tooth*,* from the resemblance of its teeth to the modern *Iguana*, and which is especially found in the Wealden, is calculated to have been no less than seventy feet long, fifty-two and a half of which went to the tail. It is one of the beasts that Mr. Hawkins modelled for the Crystal Palace gardens, and the following is part of his description of his work :—

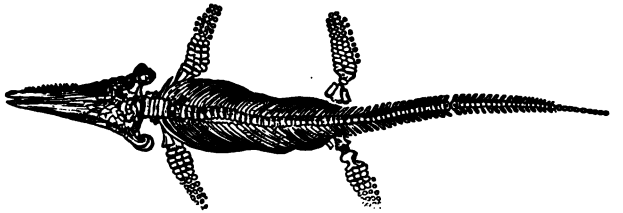
A skeleton had been found at Horsham, and this, he says, "was the animal the mould of which I converted into a *salle-à-manger*, and in which I had the honour of receiving Professor Owen, Professor E. Forbes, and twenty of my scientific friends to dinner on the last day of the year 1853." After describing the study of anatomy necessary to put the flesh of these beasts on their bones, he continues: "Some of these models contained thirty tons of clay, which had to be supported on four legs, as their natural history would not allow of my having recourse to any of the expedients for support allowed to sculptors in an ordinary case. I could have no trees, nor rocks, nor foliage, to support these great bodies, which to be natural must be built fairly on their four legs. In the instance of the iguanodon, it is not less than building a house upon four columns, and the quantities of material of which the standing iguanodon is composed consist of four iron columns, nine feet long by seven inches diameter; 600 bricks: 650 2-inch half round drain-tiles; 900 plain tiles; thirty-eight casks of cement; ninety casks of broken stone, making a total of 650 bushels of artificial stone. These, with 100 feet of iron hooping and twenty feet of cubic inch bar, constitute the bones, sinews, and muscles of this large model, the largest of which there is any record of a casting being made."

The skeleton in the following cut is that of the *Fish-lizard*,† whose length seems to have varied from four to thirty feet. It had the back-bone of a fish, the paddles of a whale, the chest and head of a lizard, the teeth of a crocodile, and the snout of a porpoise. One kind had 210 teeth in its mouth; jaws have been

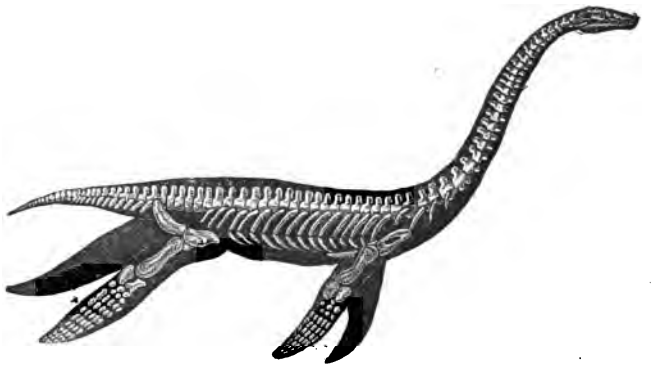
* Iguánŏdon.

† *Ichthyosaurus*, from *ichthus*, fish, and *sauros*, lizard.

found six feet in length; the socket of the eye is enormously large, in one specimen measuring fourteen inches across, and the



eye itself had wonderful power, seeing at great or little distances, in the night as in the day, in the air or in the depths of the sea. This creature was no doubt a formidable enemy to its neighbours, and amongst them to the Like-lizard.* The form of this creature is one of the strangest; in its lizard's head it had crocodile's teeth, but what a neck! It looks like the body of a serpent, and is nearly twice as long as a swan's. To these add the paddles of



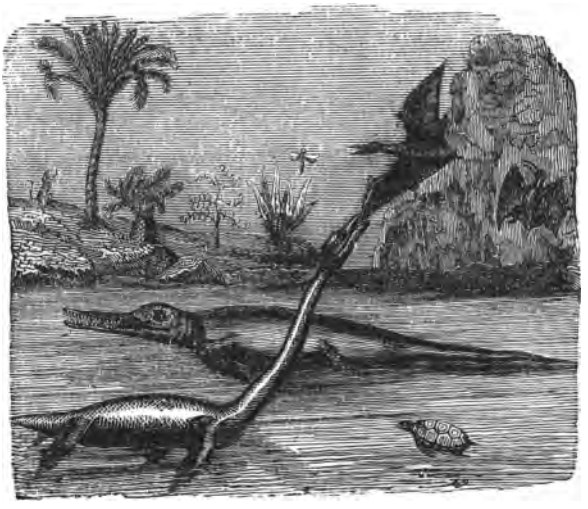
a whale and a chameleon's ribs. Its formation adapted it for the shallow water near the shore, where it darted down its long neck to seize its prey. These animals are not found longer than fifteen feet. The form is of the strangest, I said, but is matched by the

* *Plesiosaurus*, from *plesion*, near, and *sauros*, lizard.

*Wing-finger.** This was a flying lizard, with the head and neck of a bird, having teeth, sometimes as many as sixty, as well as a beak. Marks are found in connexion with its remains to show that it had the filmy wings of a bat, with hooked fingers or claws by which it could hang like the bat upon trees, and its eye proves it to have been fitted to seek its prey in the darkness of the night; it could also swim.

These strange peculiarities have led some writers to compare it to Milton's fiend, who—

> "O'er bog or steep, through straight, rough, dense, or rare,
> With head, hands, wings, or feet, pursues his way,
> And swims, or sinks, or wades, or creeps, or flies."



* *Pterodactyle*, from *pteron*, wing, and *dactulos*, finger.

CHAPTER VIII.

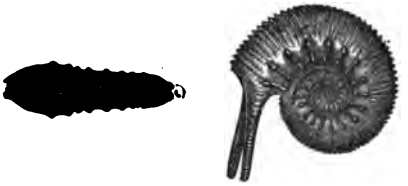
FAIRIES' NIGHT-CAPS, SQUIDS, AND URCHINS.

THE group of beds that I spoke to you about last is so deeply interesting that I must yet linger over them. The huge "earth-pressing" animals of this period will always be associated with the name of Dr. Mantell, who once practised as a physician at Lewes and Brighton, in Sussex, and last, at Clapham, and in London. But in the midst of his laborious profession he found time for scientific study, though he was continually in great bodily torture from a spinal disease; and to him geology is very deeply indebted. But not to him only; for it was Mrs. Mantell who first observed, in a walk, jutting out of the rocks, the bones which afterwards proved to be the skeleton of an Iguanodon. And here I may mention the name of another lady who did good service to geology, viz., the late Miss Mary Anning, of Lyme Regis. She it was who first found ink-bags belonging to fossil *Squids* or *Sea-pens*. Specimens have been found at Lyme Regis nearly a foot in length; and it is inferred that these animals died a violent and sudden death, as the modern squid throws out all its ink when apprized of danger. It is wonderful that, along with the huge bones of the dragons, such delicate things could have been so carefully preserved; and yet more marvellous still, the Wealden rocks display the forms of insects, with their gauzy wings laid out as neatly and as flat as if pinned on cork in the drawers of a modern cabinet. Several hundred specimens of insects or parts of insects have turned up in these beds, and we may specify dragon-flies, cockroaches, crickets, diamond-beetles, cuckoo-spit insects, and spiders. The limestone of Solenhofen, in Germany, is well known as a chief locality of these fossils. At Aix, in Provence, also, very exact specimens

have been discovered in later rocks, appearing as fresh as if buried yesterday. Some of them are of the same species as now frequent Provence, and in some of the fossils even the colouring is retained in a slight degree. This figure represents the section of an ammonite, in which you can see the outer chamber,

and also the inner chambers, the walls forming elegant curves, and the marks where the tube pierced them in contact with the shell.

The next figure is that of another ammonite, *A. Jason*, having



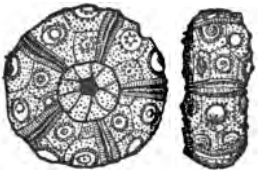
a peculiar beak or mouth. In earlier times it was supposed that these shells were the tails of animals or worms turned into stone, or that they were petrified snakes, and the mouth was often cut into the form of a serpent's head, or even a stone head fixed on them. In the lines—

> Of thousand snakes each one
> Was changed into a coil of stone
> When holy Hilda prayed,*

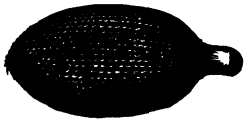
Sir W. Scott alludes to the legend of the miraculous transformation of snakes by some of the saints; whence the shells were

* Marmion, 2—13.

called Snake-stones. The figure that follows is that of a very beautiful fossil, different kinds of which are abundant in this and the



next series of rocks. They are often called by the common people *Fairies' Night-caps*, *Shepherds'-crowns*, and *Fairy-loaves*. They are like the *Sea-egg*, *Sea-urchin*, or *Sea-hedgehog* found on our coasts, which you may often see placed as ornaments on drawing-room what-nots and tables. The shell or case is a flattened sphere, and is covered over with little spines or prickles; in the middle is the mouth set round with the teeth, which has been called *Diogenes' lantern*. The fossils of the sort figured * above, and of which two views are given, one displaying the mouth, were furnished not with quills or spines but with clubs, as here:—†



The round markings on the shell are the bosses about which the clubs moved and worked, attached to them by cartilage. Nevertheless they are generally found near their own clubs, as their habits of burrowing in the soft sand would prevent their parts from being dispersed, and "hundreds of beautiful examples, having their spines spread out on the face of the rock, are found lying in the positions they evidently occupied when living. The quarries near Calne and Chippenham, in Wiltshire, are celebrated for such fossils." ‡ To this formation belongs the petrified

* *Cidaris coronata.* † Club of *Cidaris Glandiformis.*

‡ Mantell. Medals of Creation, vol. i., p. 313.

forest in the "dirt-bed" of the Isle of Portland. This bed, about an inch in thickness and covered by three layers of various rocks—limestone and clay, contains numerous trunks and branches of trees. "But the most remarkable fact," says Dr. Mantell, "is the position of the trees and plants in the 'dirt-bed;' for they are still erect, as if they had been petrified while growing in their native forests, with their roots in the vegetable soil, and their trunks extending into the limestone above. On one of my visits to the island, the surface of a large area of the 'dirt-bed' was cleared, and the appearance presented was most striking. The floor of the quarry was literally strewn with fossil wood, and before me was a petrified forest; the trees and plants, like the inhabitants of the city in the Arabian story, being converted into stone, yet still remaining in the places which they occupied when alive! Some of the trunks were surrounded by a conical mound of calcareous earth, which had evidently, when in the state of mud, accumulated round the stones and roots. The upright trunks were generally a few feet apart, and but three or four feet high; their summits were broken and splintered, as if they had been snapped or wrenched off by a hurricane at a short distance from the ground. Some were two feet in diameter, and the united fragments of one of the prostrate trunks indicated a total length of from thirty to forty feet. The external surface of all the trees I examined was weather-worn, and resembled that of posts or piers within reach of the tides, and subjected to the alternate influence of the water and atmosphere; there are but seldom any vestiges of the bark." *

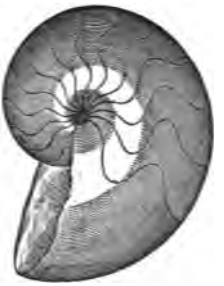
* Wonders of Geology, pp. 399, 400.

CHAPTER IX.

HUNDREDS AND THOUSANDS, JOHNNY DORIES AND THUNDERBOLTS.

NE of our poets has said, "Where is the dust that has not been alive?" and this is so in a larger sense than he intended. Since Young's day, the microscope has revealed worlds which then were out of sight. This is peculiarly true of the beds of chalk at which we are now arrived. What, however, is called the chalk formation contains more than the white mineral which we know as chalk, and which forms only the upper beds. Under this is a clay called Gault, and under this a sand called Greensand. Of this lowest bed all the sand is not green, but of all colours, white, red, yellow, and black, like the sands at Alum Bay, in the Isle of Wight. It is found in Surrey, near Reigate, besides other parts. The Gault is a stiff clay affording many fossils, which soon crumble away upon exposure to the air; and the highest beds are composed of chalk, white and sometimes red, forming many of our sea-cliffs and the downs in the south-east of England. The chalk districts generally are noted for their rural beauty; hills and valleys with smooth flowing outline, having no rugged peaks, but easy waves and undulations. At this period, Calais, Dunkirk, and Paris were at the bottom of a large gulf, in which were also Cambridge and London. Oxford was on the coast, and Holland and some adjacent parts were altogether submerged. Subsequently, when the bed of this sea was raised, England and France were united across the Straits of Dover by chalk downs, and their chalk cliffs now stand face to face. The white chalk under the microscope is found to be a collection of exceedingly minute shells and corals, so very small that a solid inch contains more than a million.

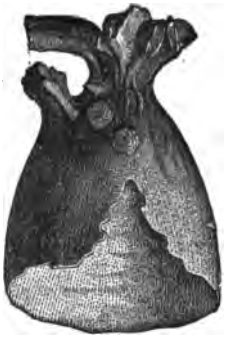
These creatures are still swarming in our seas, and hourly in the same manner as of yore forming beds of limestone or chalk at the bottom. Nearly four millions of them have been counted in an ounce of sea-sand. From the larger shells found in chalk, here is a figure of a beautiful Nautilus—



Among the chambered shells of the chalk are others of a different shape, as though an ammonite were pulled out, and curves were left at the ends only. Some of these are very large, exceeding two feet in length; and we may add to these the curious fossils generally known as *Thunderbolts*,* long, round, pointed at one end and hollow at the other. It is agreed that they are the bones of a sort of cuttle-fish which possessed an ink-bag; but no traces of the soft parts have been discovered. The occurrence of flint is a striking peculiarity of this formation, and it is found either in sheets or in lumps. No one can have looked at the face of chalk cliffs containing flints (for some chalk is without them) without admiring the extreme regularity of the rows and lines, and perhaps wondering how they got there; and this indeed is not very easy to understand; but it seems probable that quantities of heated water, charged with silex, were poured into the chalk seas, and that these particles collected round a shell or sponge, or other remains, and when cooled or hardened formed our flints. That the flints were originally

* Belemnites.

liquid appears evident from the sharp impressions of shells upon them, and the bones, shells, and other remains found inside them. A fragment of flint may often be picked up from the roadside or the garden walk with the impression on it of a shell, or two or three bosses of a sea-urchin. There are many sponges also which have been silicified, *i.e.*, turned into silex or flint, by the filling of their pores with it. This is such a sponge—



Sometimes the sponge has quite decayed, and only a little white powder is found in the cavities, some of which are lined with chalcedony. In the British Museum are some round flints containing water, which rattle like a cocoa-nut when shaken. The flint is formed in some parts in sheets, and stretching over miles in extent.

One of the old Lizards or Sea-dragons is found to have lived into this period; it is called the Mosa Lizard,* from its being found first in the valley of the Meuse, near Maestricht. Bones and teeth have been discovered in the English chalk, but a curious story is connected with the Maestricht skeleton. In the year 1770 some workmen, while blasting part of St. Peter's Mountain, perceived protruding from the rock some enormous jaw-bones. A man of science of the town, named

* Mosasaurus.

Hoffmann, hearing of the discovery, superintended for some weeks the labour of extricating the bones from the hard rock, and at last, to his extreme delight, carried off the almost complete skeleton of a new lizard, about twenty-five feet long. But the canon of the cathedral, on the ground of being lord of the manor, forced him by a vexatious lawsuit to give up his prize. It remained in the canon's possession till in the French Revolution the town of Maestricht was bombarded by the French army, who, knowing of the existence of the fossil, would not fire upon that part of the town. The canon guessing their reason, hid his treasure in a secret cellar; but when the town was taken, the French forced him to give up his possession, which was transferred to enrich the splendid collection at Paris, in the *Jardin des Plantes*.

Amongst the other important remains of the chalk may be enumerated crabs and lobsters, sharks' teeth, some sharp and pointed and highly polished, others broad and flat, with ridges or plaitings running across them. Turtles, and upwards of ninety species of curious fishes, resembling the perch, salmon, and johnny dory, close my list.

CHAPTER X.

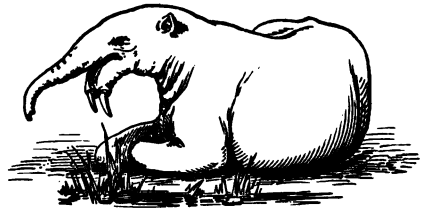
CUVIER'S CHARNEL HOUSE. DREADFUL BEASTS. OLD BEASTS.

E are getting on apace now, and shall soon have our heads above-ground, for we have only two layers of crust remaining. As we get upwards we find a larger number of creatures like those which are living on the earth at present; and it is calculated that in the deposits of shells in Sicily belonging to the last period of the Tertiary formation which succeeds to the Chalk, ninety-five out of every hundred are of recent species; but in the fossil shells of

London and Paris, both of which were at the bottom of the sea in the first period, only seven out of two hundred are recent. This system, as we have found in others, will always be associated with the name of the celebrated Baron Cuvier, the founder, indeed, of the science of fossil anatomy. In the neighbourhood of Paris are beds of gypsum, the well-known "Plaster of Paris," in which were found a large number of fossil bones of extinct animals. It was upon a confused collection of these in the museums of Paris, exhibiting a strange disorder, that Cuvier began to work. His task was to form single bones out of their broken parts, and to construct entire skeletons out of the mass of bones. The difficulties vanished before his perseverance and genius; and, as it has been said, "fragment sprang into union with fragment, bone claimed kindred with bone, and as if by the wand of an enchanter, new species of animals rose up like sudden creations, exhibiting to the astonished sage the forms and the attributes of once living beings, which the eye of man had never seen, and which his wildest fancies could never have conceived."

Cuvier himself describes his work and his feelings:—"I found myself as if placed in a charnel house, surrounded by mutilated fragments of many hundred skeletons of more than twenty kinds of animals piled in confusion around me. The task assigned to me was to restore them all to their original positions. At the voice of Comparative Anatomy every bone and fragment of a bone resumed its place. I cannot find words to express the pleasure I experienced in seeing as I discovered one character, how all the consequences I predicted from it were successively confirmed: the feet were found to accord with the characters announced by the teeth; the teeth were in harmony with those indicated beforehand by the feet. The bones of the legs and thighs, and long connecting portion of the extremities, were found set together precisely as I had arranged them before. My conjectures were verified by the discovery of the parts entire. In short, each species was, as it were, reconstructed from a single one of its component elements."

The figure here following is one of the huge creatures of this time: the Gigantic Dreadful Beast:—*



It has been modelled by Mr. Hawkins for the Crystal Palace Gardens, and is always represented lying down, as none of the bones of its lower extremities have been found. It was eighteen feet in length, thick-skinned like an elephant, with a trunk, tusks like the Walrus, and resembling in many respects the modern *Tapirs*. Its food was grass and roots. Its shoulder-blade, which is like the Mole's, shows it was adapted for digging and grubbing; but the most singular feature is the enormous lower jaw. This was nearly four feet long, and heavily loaded with the tusks. The weight of its head would show that it was not at home on land, but, like the tapir, sought its food in the water. "If we suppose the tusks to be employed for raking and grubbing up by the roots large aquatic vegetables from the bottom, they would under such service combine the mechanical powers of the pick-axe with those of the horse-harrow of modern husbandry.

"The weight of the head placed above these downward tusks would add to their efficiency for the service here supposed, as the power of the harrow is increased by loading it with weights. The tusks may also have been applied to hook on the head of the animal to the bank, with the nostrils sustained above the water, so as to breathe securely during sleep, whilst the body remained floating at perfect ease beneath the surface. These tusks might have been further used, like those in the upper jaw of the Walrus,

* Deinotherium Giganteum.

to assist in dragging the body out of the water; and also as formidable instruments of defence."*

A similar animal, but of smaller dimensions, was the Old Beast.†

Of a different genus was the Unarmed Beast,‡ called from its having no tusks or offensive arms. Remains of these animals have been found in the Isle of Wight at Seafield. From their teeth we find that they were vegetarians like the tapirs. The

foot had only two toes, and they are the earliest cloven-hoofed animals known in a fossil state.

The creature represented above was about the size of the ass, low on the limbs, and having a powerful tail as long as the rest of its body. This tail, like the Otter's, was flattened at the base; a form which enabled them to swim and plunge like the Hippopotamus. Their bodies were slightly covered with hair, and their ears short and erect. It is observable that in these deposits are found the first fossil apes and monkeys, and a fossil fox.

There is an abundance of beautiful shells, of which the following specimen in the next page is an exceedingly pretty sort.§

It was at the close of this period that by some great convulsion of the earth the principal chain of the Alps was upheaved. It

* Dr. Buckland. Bridgewater Treatise. † Palæotherium.
‡ Anoplotherium Commune. § Cerithium Hexagonum.

may puzzle you at first to think how this can be determined; but the proof is very simple, and very curious, and may be easily explained.

All the beds of rocks which were laid down before the mountain was raised up will be found round its roots in a sloping position, whilst those which were laid down after its upheaval will be flat.

From such observations it has been concluded that the chain of the principal Alps was elevated at the close of the Tertiary period; but the Grampians in Scotland, to take another instance, much earlier, at the close of the old red sandstone, since the coal beds in connection with them are the first that are observed to be flat.

CHAPTER XI.

ICED MAMMOTH—THE BIG BEAST—HYENA CAVES.

HOUGH we now come nearer still to our modern times, we have not yet done with our gigantic companions. For in the rock formed above the Tertiary, where

"Stuck out
The bones of some vast bulk that lived and roar'd
Before man was"*

one of the most interesting geological discoveries was made. About the beginning of this century, a Siberian fisherman observed an appearance in an ice cliff which aroused his attention; and some time afterwards he found a large tusk projecting from the ice. More of the ice gradually melted, and at length fell down the huge carcase of a gigantic extinct elephant or *mammoth*. The tusks were nine feet long, the body sixteen feet long and twelve high. The flesh was perfectly preserved, and the neighbouring dogs and wild animals feasted on it. The skin was so heavy that ten persons could hardly carry it to the shore.

The beast had a mane and a hairy coat, and nearly forty pounds of hair were gathered up. Abundance of similar tusks were found in the ice in other places; and this creature had thus lain probably for many thousands of years imbedded in the ice, as Tennyson says:—

"An old world Mammoth bulk'd in ice."†

The skeleton was conveyed to St. Petersburg, with the skin still attached to the head and feet, and a part of the skin, with some of the hair, is now in the Museum of the Royal College of Surgeons in London. The skin, now quite dry and hard, is half an inch thick. It has been shown to be likely that the tempera-

* Tennyson. Princess, p. 68. † Princess, p. 113.

ture of that part of the earth when these animals lived was much warmer than now. The portrait that follows is that of the *big beast,** which resembled the sloth in many of its habits. A model is in the Crystal Palace Gardens. The creature had a long and strong snout with which it grubbed up roots; and was able to stand safely on its hind legs and tail, and pull trees down with its

fore legs, and in this attitude Mr. Hawkins has represented it. The fore foot was about a yard in length, and armed with strong claws. The examination of a skull has given a curious proof of the animal's habits and dangers. It was found to be fractured in two places; one over the right eye was entirely healed; the other

* Megatherium.

was over the brain, and only partly healed. Professor Owen tells us that this individual cracked its skull twice by pulling down a tree upon it, and that the second crack caused its death.

We have now to notice the occurrence of lines of immense stones and pieces of rocks, some many hundred tons in weight, that are strewn over parts of the earth, sometimes at a considerable distance from the mountains from which they were swept off. They are called *boulders* or *erratic blocks*. Upon them are often deep grooves and scratches, which are accounted for by supposing that they were carried along from their native mountains at the bottom of huge icebergs, which dropped them as they melted. We may read in modern voyages descriptions of these enormous ice mountains rising from 100 to 200 feet above the surface of the sea, and measuring sometimes a mile in circumference. These masses of ice break away from the land frequently loaded with an immense weight of gravel, stones, and fragments of rock, burdens of many thousand tons. As the mountain floats into warmer latitudes the ice melts, and lets its load drop to the bottom of

the sea. An iceberg was encountered in 1839, in the Antarctic Ocean, sailing northwards, many hundred miles from any known

land, with a large block firmly frozen into it. On the preceding page is a picture of a noted locality of these boulders in Massachusetts in America.

In England, blocks supposed to have been derived from the Cumberland and Scotch mountains cover parts of the counties of Lancashire, Cheshire, Shropshire, Staffordshire, and Worcestershire. In Sweden, fragments from the granite rocks of the north of Europe are profusely scattered about and lie in heaps and mounds :—

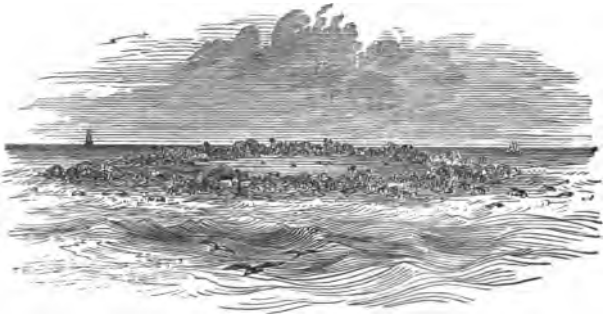
> "Huge rocks and mounds confusedly hurled,
> The fragments of an earlier world."

I must not omit to mention the celebrated bone caves. One in Franconia contains several chambers of large extent, ending in a deep chasm. The floor is thickly paved with fossil bones and teeth. A great number belong to bears ; others to hyenas, tigers, wolves, foxes, and such animals, some now extinct. It is singular that bones akin to those of the spotted hyena of the Cape of Good Hope should lie side by side with those of the glutton of Lapland. In England some of these curious caverns have been found, of which that of Kirkdale in Yorkshire is best known. It was discovered by some quarrymen in 1821, and is 245 feet long, and sometimes fourteen feet in height. The mud or clay of the floor, about a foot in thickness, was filled with bones of the hyena, and many other animals, showing marks of having been gnawed. It has been supposed that the cave was the abode of the hyenas, which carried in and preyed upon the other animals ; while some of the smaller creatures, as rabbits, rats, mice, pigeons, larks, and ducks, were drifted in by currents, or fell in through fissures in the ground.

CHAPTER XII.

LIVING MOUNTAINS—EARTH'S THUNDERS—FINGAL'S CAVE BY MOONLIGHT.

WE have almost done our task. I have been very much pleased with your company, and I hope you are not quite tired of mine. But before we part for good, I wish in this closing chapter to show you that the same changes, though not to the same extent, are going on still in this, the human period of the earth's history, as we have seen employed in the formation of the rocky crust. And first, look at this picture of a coral island, and listen to the following description of the works of these "feeblest creatures in existence."



The *polyp* insect, which builds up coral islands from the bottom of the sea, is all but invisible, and yet the mountains which they raise under the waters are hundreds of feet in height, and miles in extent. "They have built up a reef along the shores of New Caledonia for a length of 400 miles, and another which runs for 1,000 miles along the east coast of Australia.

They form also circular rings or islands rising out of the deep water. Those of small size measure fifty miles in length by twenty in breadth, so that if the ledge of coral were extended in one line it would reach 120 miles in length. Assuming such a ledge of coral to be a quarter of a mile broad and 150 feet deep, we have here a mound, compared with which the walls of Babylon, the great wall of China, the pyramids of Egypt, are but children's toys; and it is built amidst the waves of the ocean, and in defiance of its storms, which sweep away the more solid works of man."* The multitudinous insects in one reef or island, though each has a separate existence, are all connected as one community; they cease to build upwards when the top of their mountain is dry at low water, and the lower part of it forms the sepulchres of preceding generations, a

> "Stupendous mound of catacombs,
> Filled with dry mummies of the builder's worms." †

Just in the same way many thick masses of limestone and beautiful marbles were formed in the ancient times. In contrast to this slow and silent work of creation, is the quick and violent revolution produced by earthquakes and volcanoes. Man cannot boast to have seen the tremendous convulsion which raised the Alps, but a similar instance on a smaller scale was witnessed in the bursting up of Jorullo,‡ and some wonderful effects are recorded in history of the great power of volcanoes. Pompeii and Herculaneum in Italy were buried by an eruption of Mount Vesuvius. The ashes thrown out of Hecla, in 1845, fell thick within a few hours upon the islands of Scotland. An eruption in South America carried to a distance of nine miles a block of stone weighing 200 tons. A volcanic mountain is distinguished by a peculiar shape and appearance. It is conical, but the peak appears as if broken off to form the crater. Besides those mountains which are known to have been active volcanoes, there

* Ansted. Geology in Orr's Circle of Science, p. 41.
† Montgomery. Pelican Island. ‡ See chap. i., p. 35.

is a very large number which are extinct, but show the volcanic form, and in ancient times much more striking effects and changes must have been wrought by this means than we now experience. The cut represents such an extinct volcano in Asia Minor.

Earthquakes are closely connected with volcanic discharges, and may be likened to the report of a cannon when it is fired. An eruption has been heard and felt over 50,000 miles. In 1780, an earthquake in the Gulf of Mexico submerged a whole city in Jamaica. In 1782, the earth opened her mouth and swallowed up the town of Messina, in Sicily, with 80,000 inhabitants.

"What then, were they the wicked above all,
And we the righteous, whose fast anchored isle
Moved not, while theirs was rock'd like a light skiff,
The sport of every wave?" *

* Cowper. Task—The Timepiece.

And now, as it is time to shake hands, and I would not that we should part in a clap of thunder, or a terrific explosion, come with me and see the dainty columns of a natural temple, once formed by a volcanic burst, now bathed in the calm moonlight. We say adieu in Fingal's Cave in Staffa.

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As we are now getting towards the close of another year, I want to say a word or two about our Magazine. We are advancing; our "staff" is larger, our circulation is better, our correspondents are more numerous, our waste-paper basket is enlarged, our postage-stamp bill is heavier, and our prospects are brighter. But we still want help; magazine work is very hard work; and, now that there are so many to compete with, the weak soon go to the wall. So we ask you to unite with us and strengthen our efforts; do what you can to circulate *Merry and Wise* and we will try to make it worthy of your recommendation. If each subscriber would only get one other subscriber, we should be able to do a great many things which would enhance the value of the Magazine, but which we are not warranted in attempting until there is a much larger sale. *A fitting opportunity now presents itself for increasing the circulation of the Magazine, by recommending friends to purchase the* DECEMBER *number, which will contain the* COLOURED PICTURE *intended as the frontispiece to the New Volume.*

Our programme for the New Year we feel sure will give pleasure to you all. The leading story will be written by Mr. SIDNEY DARYL, a name familiar to you all, and one that many a boy and girl has learnt to idolize. Your old friends, Mr. W. H. G. KINGSTON, Mr. R. M. BALLANTYNE, Mr. EDWIN HODDER, Mr. HOPE MONCRIEFF, and others, will still contribute occasionally, and Miss ANNIE HARWOOD, who translated that capital story about "Gold Seekers and Bread Winners," will commence another story in the January Number, entitled "The Cobbler, the Clerk, and the Lawyer of Lubstein." Several new contributors will send papers during the year; amongst others, the author of Little Archie's Catechism," "Stories about St. Paul," &c., and "M. J. C.;" whose happy style in writing is only equalled by her happy style of illustrating what she writes.

And now, my young friends, I thank you all very heartily for the help you have given me during the year, for all the kind things you have said and written about the Magazine, and for all your contributions to the puzzle department. I wish you a merry Christmas and a happy New Year, and all the blessings which make life bright, and cheerful, and joyous. Believe me, very sincerely yours, OLD MERRY.

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